ABSTRACT

**Key words:** Gabions, reinforced soil, finite element analysis, cohesionless backfill, parametric studies, material properties, geometric properties, design charts, cost effectiveness

Gabion faced retaining walls are essentially semi rigid structures that can generally accommodate large lateral and vertical movements without excessive structural distress. Because of this inherent feature, they offer technical and economical advantage over the conventional concrete gravity retaining walls. Although they can be constructed either as gravity type or reinforced soil type, this work mainly deals with gabion faced reinforced earth walls as they are more suitable to larger heights.

The main focus of the present investigation was the development of a viable plane strain two dimensional non linear finite element analysis code which can predict the stress-strain behaviour of gabion faced retaining walls - both gravity type and reinforced soil type. The gabion facing, backfill soil, in-situ soil and foundation soil were modelled using 2D four noded isoparametric quadrilateral elements. The confinement provided by the gabion boxes was converted into an induced apparent cohesion as per the membrane correction theory proposed by Henkel and Gilbert (1952). The mesh reinforcement was modelled using 2D two noded linear truss elements. The interactions between the soil and the mesh reinforcement as well as the facing and backfill were modelled using 2D four noded zero thickness line interface elements (Desai et al., 1974) by incorporating the nonlinear hyperbolic formulation for the tangential shear stiffness. The well known hyperbolic formulation by Duncan and Chang (1970) was used for modelling the non-linearity of the soil matrix. The failure of soil matrix, gabion facing and the interfaces were modelled using Mohr–Coulomb failure criterion. The construction stages were also modelled.

Experimental investigations were conducted on small scale model walls (both in field as well as in laboratory) to suggest an alternative fill material for
the gabion faced retaining walls. The same were also used to validate the finite element programme developed as a part of the study. The studies were conducted using different types of gabion fill materials. The variation was achieved by placing coarse aggregate and quarry dust in different proportions as layers one above the other or they were mixed together in the required proportions. The deformation of the wall face was measured and the behaviour of the walls with the variation of fill materials was analysed. It was seen that 25% of the fill material in gabions can be replaced by a soft material (any locally available material) without affecting the deformation behaviour to large extents. In circumstances where deformation can be allowed to some extents, even up to 50% replacement with soft material can be possible.

The developed finite element code was validated using experimental test results and other published results. Encouraged by the close comparison between the theory and experiments, an extensive and systematic parametric study was conducted, in order to gain a closer understanding of the behaviour of the system. Geometric parameters as well as material parameters were varied to understand their effect on the behaviour of the walls.

The final phase of the study consisted of developing a simplified method for the design of gabion faced retaining walls. The design was based on the limit state method considering both the stability and deformation criteria. The design parameters were selected for the system and converted to dimensionless parameters. Thus the procedure for fixing the dimensions of the wall was simplified by eliminating the conventional trial and error procedure. Handy design charts were developed which would prove as a hands-on tool to the design engineers at site. Economic studies were also conducted to prove the cost effectiveness of the structures with respect to the conventional RCC gravity walls and cost prediction models and cost breakdown ratios were proposed.

The studies as a whole are expected to contribute substantially to understand the actual behaviour of gabion faced retaining wall systems with particular reference to the lateral deformations.